Негосударственное образовательное учреждение высшего образования
«Школа управления СКОЛКОВО»

Утверждено
ректор С.С. Писарев
_____
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РАБОЧАЯ ПРОГРАММА ДИСЦИПЛИНЫ
Теория игр/ Game theory

Москва
2026

Направление подготовки	38.03.02 Менеджмент
Квалификация выпускника	Бакалавр
Образовательная программа	Управление и предпринимательство 2026
Форма обучения	Очная

Трудоемкость		Контактная работа		Самостоятельная работа	Форма контроля
з.е.	часы	лекции	семинарские занятия		
4	144	24	24	96	Экзамен

1. АННОТАЦИЯ ДИСЦИПЛИНЫ

This course offers a comprehensive introduction to the fundamental concepts and analytical techniques of Game Theory, exploring how rational individuals make strategic decisions in interactive environments. Students will master core paradigms including Nash equilibrium, sequential games, mixed strategies, and bargaining theory, while applying these tools to diverse fields such as economics, political science, biology, and business strategy. By bridging theoretical models with real-world scenarios like auctions, market competition, and evolutionary dynamics, the curriculum equips learners with the critical thinking skills to predict, interpret, and influence outcomes in competitive and cooperative settings.

2. ПЛАНИРУЕМЫЕ РЕЗУЛЬТАТЫ ОСВОЕНИЯ ДИСЦИПЛИНЫ

В случае успешного освоения курса студенты будут:

знать

- Core concepts of game theory: players, strategies, payoff matrices, and equilibrium;
- Key classifications: cooperative vs. non-cooperative, zero-sum vs. non-zero-sum, simultaneous vs. sequential games, complete vs. incomplete information;
- Formal definitions of Nash equilibrium (pure and mixed strategies), dominant and dominated strategies;
- Principles of backward induction and subgame perfect equilibrium in sequential games;
- Standard models: Prisoner's Dilemma, Chicken, Stag Hunt, Battle of the Sexes, auctions, and bargaining problems.

уметь

- Model real-world strategic interactions as formal games (identify players, strategy sets, and payoff functions);
- Analyze simultaneous-move games to find Nash equilibria (including mixed-strategy equilibria) and eliminate dominated strategies;
- Solve sequential games using backward induction and identify subgame perfect equilibria;
- Evaluate equilibrium outcomes in terms of Pareto efficiency and social welfare;
- Apply basic auction theory and bargaining models to predict behavior in competitive bidding and negotiation settings.

владеть
- The skill of constructing both normal-form (matrix) and extensive-form (game tree) representations for applied problems in economics, business, and political science;
- Analytical and graphical techniques for identifying equilibria in pure and mixed strategies;
- The ability to interpret game-theoretic analysis for strategic decision-making: choosing best responses, identifying conditions for cooperation, and assessing the value of information;
- Critical assessment of model assumptions (rationality, common knowledge) and their applicability to real-world situations with bounded rationality.

Дисциплина направлена на развитие следующих компетенций и их индикаторов:

Код компетенции	Формулировка компетенции и/или ее индикатора (ов)
ОПК-1.	**Способен решать профессиональные задачи на основе знаний (на промежуточном уровне) экономической, организационной и управленческой теории**
ОПК-1-1.	Знает основы математической, экономической, социальной и управленческой теории и использует знания для решения профессиональных задач
ОПК-1-2.	Формулирует профессиональные задачи, используя понятийный аппарат математической, экономической, социальной и управленческой наук
ОПК-1-3.	Применяет инструментарий экономико-математического моделирования для постановки и решения профессиональных задач выявления причинно-следственных связей и оптимизации деятельности объекта управления
ОПК-2.	**Способен осуществлять сбор, обработку и анализ данных, необходимых для решения поставленных управленческих задач, с использованием современного инструментария и интеллектуальных информационно-аналитических систем**
ОПК-2-1.	Определяет источники данных и выбирает методы и инструменты поиска, корректно осуществляет анализ литературы и документов
ОПК-2-2.	Применяет методы сбора, обработки и анализа данных, необходимых для решения управленческих задач, с использованием современных цифровых технологий, воспринимает, анализирует, запоминает и передает информацию с использованием цифровых средств, а также с помощью алгоритмов при работе с полученными из различных источников данными
ОПК-5.	**Способен использовать при решении профессиональных задач современные информационные технологии и программные средства, включая управление крупными массивами данных и их интеллектуальный анализ**

ОПК-5-1.	Использует цифровые технологии, включая информационные системы и базы данных, системы искусственного интеллекта и системы интеллектуального анализа и обработки данных для решения профессиональных задач
ОПК-5-2.	Оценивает возможности и целесообразность использования цифровых технологий в деятельности организации, использует современные цифровые технологии и программные продукты для решения профессиональных задач

3. СОДЕРЖАНИЕ И СТРУКТУРА ДИСЦИПЛИНЫ

Название раздела/темы	Всего часов	Трудоемкость (час.) по видам учебных занятий			
		Контактная работа			Самостоятельная работа
		Всего	Лекции	Семинары	
Тема 1. Normal-Form Games and Dominant Strategies	24	8	4	4	16
Тема 2. Nash Equilibrium in Pure and Mixed Strategies	24	8	4	4	16
Тема 3. Sequential Games and Subgame Perfect Equilibrium	24	8	4	4	16
Тема 4. Repeated Games and Cooperation	24	8	4	4	16
Тема 5. Games with Incomplete Information and Bayesian Games	24	8	4	4	16
Тема 6. Cooperative Game Theory and Bargaining	24	8	4	4	16
Итого	144	48	24	24	96

Тема 1. Normal-Form Games and Dominant Strategies

This topic introduces the basic building blocks of game theory: players, strategies, and payoffs represented in a matrix (normal form). Students learn to identify strictly and weakly dominant strategies, eliminate dominated strategies, and solve simple games using iterated elimination. Classic examples such as the Prisoner's Dilemma and the Battle of the Sexes illustrate why rational individual choices may lead to collectively suboptimal outcomes and how strategic

reasoning works under complete information.

Тема 2. Nash Equilibrium in Pure and Mixed Strategies

Focusing on the most fundamental solution concept in game theory, this topic defines Nash equilibrium as a situation where no player can unilaterally improve their payoff. Students learn to find pure-strategy Nash equilibria in coordination games, zero-sum games, and competitive settings. The topic then extends to mixed strategies, where players randomize over actions to make opponents indifferent, using examples like penalty kicks in soccer and inspection games.

Тема 3. Sequential Games and Subgame Perfect Equilibrium

This topic shifts from simultaneous to sequential moves, where players act in a known order and later players observe earlier actions. Using extensive-form representations (game trees), students learn backward induction as a method for solving such games. The concept of subgame perfect equilibrium (SPE) is introduced to eliminate non-credible threats. Classical examples include the Entry Deterrence game, the Ultimatum Game, and sequential bargaining, illustrating how commitment and credibility shape strategic outcomes.

Тема 4. Repeated Games and Cooperation

This topic explores how the shadow of the future affects strategic behavior when the same game is played multiple times. Students analyze finitely and infinitely repeated games, learning the logic of trigger strategies, tit-for-tat, and the Folk Theorem, which shows that cooperation can emerge as an equilibrium under sufficient patience. Applications include cartel stability in oligopolies, price wars, and the evolution of trust in social and economic interactions.

Тема 5. Games with Incomplete Information and Bayesian Games

This topic introduces Bayesian games, where players have private information and form beliefs using prior distributions. Students learn to analyze first-price and second-price sealed-bid auctions, signaling games, and the concept of Bayesian Nash equilibrium. Real-world applications include job market signaling, political campaigns, and mechanism design in online advertising auctions.

Тема 6. Cooperative Game Theory and Bargaining

This topic moves beyond non-cooperative models to analyze situations where players can form binding agreements and coalitions. Students learn core concepts such as the Shapley value (fair division of payoffs based on marginal contributions), the core of a cooperative game (stable allocations), and the Nash bargaining solution (axiomatic approach to dividing surplus). Applications include cost-sharing in joint projects, voting power in parliaments, and fair division of resources in multi-party negotiations.

4. ОЦЕНОЧНЫЕ СРЕДСТВА И ПРИМЕРЫ ЗАДАНИЙ ДЛЯ ОЦЕНКИ РЕЗУЛЬТАТОВ ОСВОЕНИЯ ДИСЦИПЛИНЫ

4.1 Текущий контроль

Оценка за курс складывается из следующих видов заданий текущего контроля, каждый из которых обладает своим весом в общей системе:

Компоненты	Процент в итоговой оценке
Домашние работы	60%
Контрольные работы	40%

На курсе используется 10 балльная система оценивания. За каждое задание студент получает от 1 до 10 баллов. Итоговый балл за каждый вид заданий рассчитывается как среднее арифметическое всех полученных баллов за все задания в рамках одного вида (О1, О2). Невыполненное в срок задание оценивается в 0 баллов.

Общая оценка за курс (О) рассчитывается как:

$$О = О1х0,6 + О2х0,4$$

Если по результатам текущего контроля студент получил положительную оценку (не ниже «удовлетворительно»), оценка за промежуточную аттестацию выставляется автоматически.

Домашние работы

Самостоятельное выполнение заданий дает студенту возможность углубить уровень усвоения материала, развить навык самостоятельного решения комплексных, многоэтапных задач, навык работы с литературой и программным обеспечением (при необходимости). Предполагается выполнение 6 домашних заданий. Примеры заданий приведены в п. 4.3.

Контрольные работы

Проводятся в классе, проверяют способности применять знания в условиях ограниченного времени, без использования внешних источников. В процессе обучения проводится 2 контрольные работы.

Примеры заданий приведены в п. 4.3.

4.2 Промежуточная аттестация

Студентам, набравшим достаточные для удовлетворительной оценки баллы за текущий контроль, оценка за дисциплину выставляется равной оценке за текущий контроль (См. п. 4.1)

Студентам, получившим неудовлетворительную оценку по результатам текущего контроля, необходимо по согласованию с преподавателем сдать один или несколько компонентов текущего контроля. Преподаватель вправе предложить студентам выполнить задание, не повторяющее задание текущего контроля, но проверяющее аналогичные знания, умения и навыки.

4.3 Примеры заданий

Примеры домашних заданий

Homework 1

Topic: Normal-form games, dominant/dominated strategies, iterated elimination.

Task: Consider the following 2×2 game matrix (Player 1 chooses rows: Top/Bottom; Player 2 chooses columns: Left/Right):

	Left	Right
Top	3,2	1,1
Bottom	2,3	0,0

1. Does any player have a strictly dominant strategy? Explain.
2. Does any player have a strictly dominated strategy? If yes, eliminate it.
3. Apply iterated elimination of strictly dominated strategies (IESDS). What is the outcome?
4. Now consider the Prisoner's Dilemma with payoffs (5,5) for (Cooperate, Cooperate), (0,10) for (Cooperate, Defect), (10,0) for (Defect, Cooperate), (2,2) for (Defect, Defect). Find dominant strategies and the Nash equilibrium. Why is the outcome Pareto-inefficient?

Deliverable: Written answers with step-by-step reasoning.

Homework 2

Topic: Pure-strategy and mixed-strategy Nash equilibrium.

Task: Use the following game matrix (Player 1: U/D; Player 2: L/R):

	L	R
U	2,1	0,0
D	0,0	1,2

1. Find all pure-strategy Nash equilibria (if any).
2. Calculate the mixed-strategy Nash equilibrium: find the probability p with which Player 1 plays U, and probability q with which Player 2 plays L.
3. What is the expected payoff for each player at the mixed-strategy equilibrium?
4. Bonus: Modify one payoff cell so that a second pure-strategy Nash equilibrium appears. Explain your change.
Deliverable: Algebraic derivation of mixed-strategy probabilities plus brief interpretation.

Homework 3

Topic: Extensive-form games, backward induction, subgame perfect equilibrium (SPE).
Task: Consider an entry deterrence game: an incumbent (I) faces a potential entrant (E).
- E first chooses Enter or Stay Out.
- If E stays out, payoffs are (0, 5) for (E, I).
- If E enters, I chooses Fight (price war) or Accommodate.
- Payoffs if Enter + Fight: (−2, 1) for (E, I).
- Payoffs if Enter + Accommodate: (3, 3).

1. Draw the game tree (extensive form) with labels, payoffs, and information sets.
2. Solve the game by backward induction. What is the subgame perfect equilibrium?=
3. Suppose I could commit to fighting before E's decision. Would that change the equilibrium? Explain using the concept of credible threats.
4. Discussion question: Why does the SPE concept eliminate non-credible threats?
Deliverable: Game tree diagram, SPE strategy profile, and 2–3 sentences of explanation.

Homework 4

Topic: Finitely and infinitely repeated games, trigger strategies, Folk Theorem.
Task: Consider the Prisoner's Dilemma with stage-game payoffs: C,C = (3,3); C,D = (0,5); D,C = (5,0); D,D = (1,1).
1. Assume the game is repeated 10 times with no discounting (δ = 1). Is cooperation (C,C) every round possible as a subgame perfect equilibrium? Why or why not?
2. Now assume the game is infinitely repeated with discount factor $\delta \in (0,1)$. Find the condition on δ such that the grim trigger strategy (start with C; if anyone defects, play D forever) sustains cooperation in every period.
3. For δ = 0.8, does cooperation hold? For δ = 0.4? Show your inequality.
4. Explain in one sentence what the Folk Theorem implies about possible payoffs in infinitely repeated games.
Deliverable: Algebraic derivation of the discount factor threshold plus short explanations.

Homework 5

Topic: Bayesian games, private information, Bayesian Nash equilibrium.
Task: Consider a sealed-bid first-price auction with two bidders.
- Each bidder's value v_i is independently drawn from a uniform distribution on [0,1].
- Each bidder knows their own v_i but not the opponent's.
- Bidders simultaneously submit bids $b_i \geq 0$. Payoff for bidder i is: $v_i - b_i$ if $b_i > b_j$, $(v_i - b_i)/2$ if tie, and 0 if $b_i < b_j$.

1. Assume each bidder uses a linear strategy: $b_i(v_i) = a \cdot v_i$. Find the symmetric Bayesian Nash equilibrium (solve for a).
2. What is the expected revenue of the auctioneer in equilibrium?

3. How would the equilibrium change in a second-price sealed-bid auction? (No math required — state the dominant strategy and explain.)
4. Define the term *winner's curse* in one sentence.
Deliverable: Derivation of a, final numerical coefficient, and brief written answers.

Homework 6

Topic: Cooperative games, Shapley value, the core, Nash bargaining solution.
Task: Three players (A, B, C) form a coalition to complete a project.
- Any single player earns 0 alone.
- Any pair earns $100 (to be split).
- The grand coalition (all three) earns $150.

1. Compute the Shapley value for each player. Show all marginal contributions.
2. Determine whether the payoff vector (50, 50, 50) is in the core. Explain why or why not.
3. Now consider a bargaining problem between two players splitting $100. Player 1 has disagreement payoff 20, Player 2 has 10. Using the Nash bargaining solution (symmetric, maximizing product of gains), find the division of surplus.
4. Compare the Shapley value and the Nash bargaining solution: when would you use each?
Deliverable: Step-by-step Shapley calculation, core check, Nash bargaining result, and a short comparison paragraph.

Примеры заданий контрольных работ

I. Midterm Exam (Covering Topics 1–3)
Type: In-class closed-book exam
Time: 70 minutes
Total points: 100

Problem 1 – Normal-form games and dominant strategies (25 points)
Consider the following game matrix (Player 1: rows A/B; Player 2: columns X/Y/Z):

	X	Y	Z
A	4,2	1,3	3,1
B	2,1	2,2	1,4

1. (5 pts) Does Player 1 have a strictly dominant strategy? Explain.
2. (5 pts) Does Player 2 have a strictly dominant strategy? Explain.
3. (10 pts) Apply iterated elimination of strictly dominated strategies (IESDS). Show each step. What is the final outcome?
4. (5 pts) Is the final outcome a Nash equilibrium? Why or why not?

Problem 2 – Pure and mixed strategy Nash equilibrium (30 points)
Use the following 2×2 game (Player 1: U/D; Player 2: L/R):

	L	R
U	3,1	0,2
D	1,2	2,0

1. (10 pts) Find all pure-strategy Nash equilibria (if any).
2. (15 pts) Find the mixed-strategy Nash equilibrium. Let p = probability Player 1 plays U, and q = probability Player 2 plays L. Compute p and q.

3. (5 pts) Calculate each player's expected payoff at the mixed-strategy equilibrium.

Problem 3 – Sequential games and subgame perfect equilibrium (25 points)
Consider the following sequential game:
- Player 1 moves first and chooses Left or Right.
- If Player 1 chooses Left, the game ends with payoffs (4, 2) for (P1, P2).
- If Player 1 chooses Right, Player 2 moves and chooses Up or Down.
    - If Up: payoffs (1, 1)
    - If Down: payoffs (3, 0)

1. (10 pts) Draw the extensive-form (game tree) of this game. Clearly label players, actions, and payoffs.
2. (10 pts) Solve the game using backward induction. Write the subgame perfect equilibrium (strategies and path).
3. (5 pts) Explain why the equilibrium path is credible.

Problem 4 – Short conceptual questions (20 points)
Answer any two of the following (10 points each):
1. Explain the difference between a *strictly dominant strategy* and a *weakly dominant strategy*. Give an example of each.
2. Why is the concept of *subgame perfect equilibrium* stronger than simple Nash equilibrium in sequential games?
3. In the Prisoner's Dilemma, both players have a dominant strategy to defect, yet the cooperative outcome (C,C) would be better for both. What assumption of classical game theory leads to this paradox?

II. Final Test (Covering Topics 4–6)

Course:		Game	Theory
Type:	In-class	closed-book	exam
Time:		75	minutes

Total points: 100

Problem 1 – Repeated games and cooperation (25 points)
Two firms play an infinitely repeated Prisoner's Dilemma. Stage-game payoffs:

	Cooperate	Defect
Cooperate	4,4	0,6
Defect	6,0	1,1

Discount factor is $\delta \in (0,1)$.
1. (5 pts) What is the one-shot Nash equilibrium of this stage game? Justify.
2. (15 pts) Suppose both firms use the *grim trigger strategy*: start with Cooperate; if either firm defects, play Defect forever. Derive the condition on δ under which cooperation (C,C) in every period is a subgame perfect equilibrium.
3. (5 pts) For $\delta = 0.6$, will cooperation be sustained? What about $\delta = 0.3$? Explain briefly.

Problem 2 – Bayesian games and auctions (25 points)
Consider a first-price sealed-bid auction with two bidders. Each bidder's private value v_i is uniformly distributed on [0,1]. Bidders simultaneously submit bids $b_i \geq 0$. Payoff for bidder i is:

v_i − b_i if b_i > b_j,
(v_i − b_i)/2 if tie,
0 if b_i < b_j.
1. (5 pts) What is the *symmetric linear strategy* assumption? (Write the form b_i(v_i) = a·v_i.)
2. (15 pts) Find the symmetric Bayesian Nash equilibrium: solve for coefficient a.
3. (5 pts) What is the auctioneer's expected revenue? (No need to recompute — state the result from equilibrium.)

Problem 3 – Cooperative game theory and Shapley value (25 points)
Three players (1, 2, 3) can form coalitions. Coalition values:
- v(1) = v(2) = v(3) = 0
- v(1,2) = 60, v(1,3) = 50, v(2,3) = 40
- v(1,2,3) = 90
1. (15 pts) Compute the Shapley value for each player. Show all marginal contributions for all possible orders of entry.
2. (10 pts) Check whether the payoff vector (30, 30, 30) is in the core. If not, find an improving coalition.

Problem 4 – Bargaining and Nash bargaining solution (25 points)
Two players must split $200. Their disagreement (fallback) payoffs are:
- Player A: 40
- Player B: 20
Assume the Nash bargaining solution (symmetric, maximizing the product of gains from disagreement).
1. (10 pts) Write the expression for the Nash product. Let x be Player A's share. Set up the maximization problem.
2. (10 pts) Find the bargaining outcome (final division of $200) for both players.
3. (5 pts) How would the solution change if Player A's disagreement payoff rises to 80? Explain without recalculating fully.

5. УЧЕБНО-МЕТОДИЧЕСКОЕ И ИНФОРМАЦИОННОЕ ОБЕСПЕЧЕНИЕ ДИСЦИПЛИНЫ

5.1 Литература

1. Челноков, А. Ю. Теория игр : учебник и практикум для вузов / А. Ю. Челноков. — Москва : Издательство Юрайт, 2026. — 223 с. — (Высшее образование). — ISBN 978-5-534-00233-1. — Текст : электронный // Образовательная платформа Юрайт [сайт]. — URL: https://urait.ru/bcode/583218 (дата обращения: 04.06.2026).
2. Шагин, В. Л. Теория игр для экономистов : учебник и практикум / В. Л. Шагин. — 2-е изд., испр. и доп. — Москва : Издательство Юрайт, 2026. — 223 с. — (Высшее образование). — ISBN 978-5-534-15424-5. — Текст : электронный // Образовательная платформа Юрайт [сайт]. — URL: https://urait.ru/bcode/583244 (дата обращения: 04.06.2026).

5.2 Электронные образовательные ресурсы

Материалы дисциплины размещены в LMS: https://l.skolkovo.ru/login/index.php.

6. ЛИЦЕНЗИОННОЕ И СВОБОДНО РАСПРОСТРАНЯЕМОЕ ПРОГРАММНОЕ ОБЕСПЕЧЕНИЕ

Операционная система Simple Linux, браузер Yandex браузер, антивирусное ПО Calmantivirus.
Свободно распространяемое ПО, в том числе отечественного производства:
Офисный пакет Libre Office, Okular PDF Reader, 7-Zip Архиватор, GIMP Редактирования фотографий, Inkscape Векторная графика, Blender 3D графика, Kdenlive Видеоредактор, Audacity Аудиоредактор, VLC Медиаплеер, Thunderbird Почтовый клиент, Flameshot Создание скриншотов.

7. МАТЕРИАЛЬНО-ТЕХНИЧЕСКОЕ ОБЕСПЕЧЕНИЕ ДИСЦИПЛИНЫ

Учебная аудитория для проведения занятий лекционного типа, оснащенная мультимедийным оборудованием, учебной мебелью, доской или со стенами с маркерным покрытием.
Учебная аудитория для проведения занятий семинарского типа, оснащенная мультимедийным оборудованием, учебной мебелью, доской или со стенами с маркерным покрытием.
Аудитория (коворкинг) для самостоятельной работы, оснащенная учебной мебелью, ноутбуками.
Материально-техническое обеспечение аудиторий представлено на официальном сайте https://bbask.ru/sveden/objects/.